SHIP PRODUCTION COMMITTEE
FACILITIES AND ENVIRONMENTAL EFFECTS
SURFACE PREPARATION AND COATINGS
DESIGN/PRODUCTION INTEGRATION
HUMAN RESOURCE INNOVATION
MARINE INDUSTRY STANDARDS
WELDING
INDUSTRIAL ENGINEERING
EDUCATION AND TRAINING

August 1988
NSRP 0298

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

1988 Ship Production Symposium

Paper No. 9A:
Wired for Disaster: Cableway Improvement Program

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE
AUG 1988

2. REPORT TYPE
N/A

3. DATES COVERED
-

4. TITLE AND SUBTITLE
The National Shipbuilding Research Program: 1988 Ship Production Symposium Paper No. 9A: Wired for Disaster: Cableway Improvement Program

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Surface Warfare Center CD Code 2230 - Design Integration Tools Building 192 Room 128 9500 MacArthur Blvd Bethesda, MD 20817-5700

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:

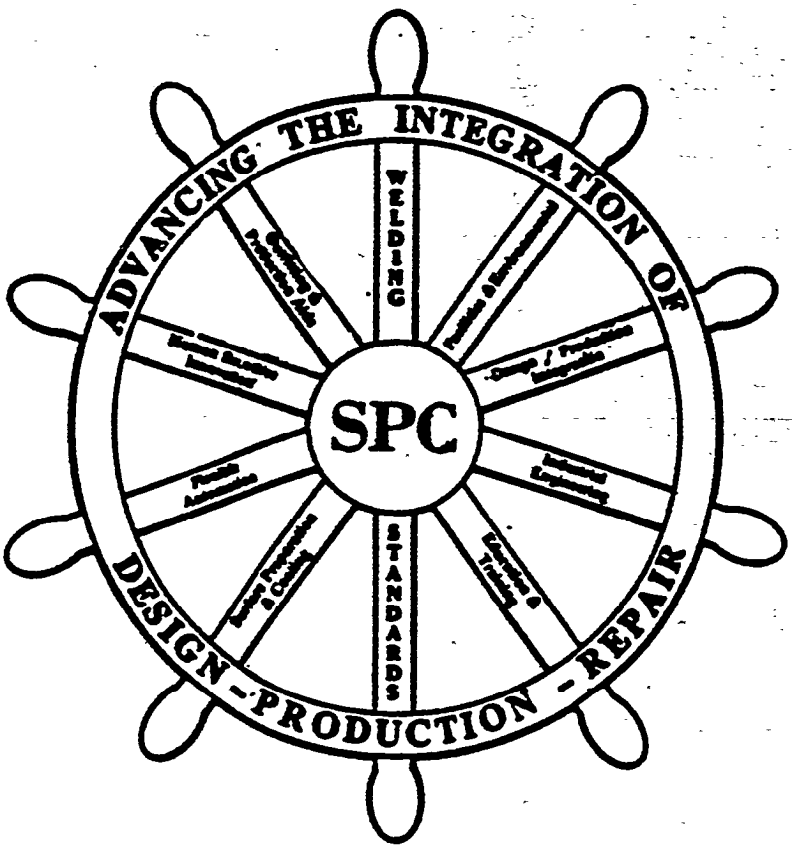
a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
unclassified	**unclassified**	**unclassified**	**SAR**	**9**	

DISCLAIMER

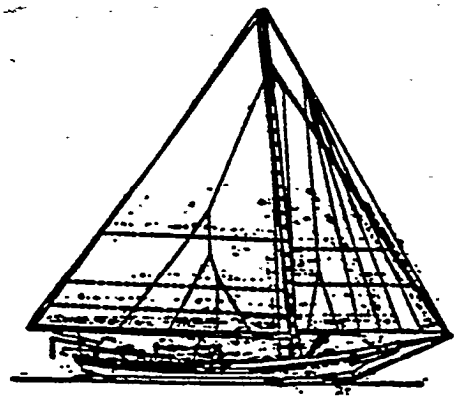
These reports were prepared as an account of government-sponsored work. Neither the United States, nor the United States Navy, nor any person acting on behalf of the United States Navy (A) makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness or usefulness of the information contained in this report/ manual, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or (B) assumes any liabilities with respect to the use of or for damages resulting from the use of any information, apparatus, method, or process disclosed in the report. As used in the above, “Persons acting on behalf of the United States Navy” includes any employee, contractor, or subcontractor to the contractor of the United States Navy to the extent that such employee, contractor, or subcontractor to the contractor prepares, handles, or distributes, or provides access to any information pursuant to his employment or contract or subcontract to the contractor with the United States Navy. ANY POSSIBLE IMPLIED WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR PURPOSE ARE SPECIFICALLY DISCLAIMED.

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM
1988 SHIP PRODUCTION SYMPOSIUM

0298



August 24-26, 1988
Edgewater Inn
Seattle, Washington



SPONSORED BY THE SHIP PRODUCTION COMMITTEE
AND HOSTED BY THE CHESAPEAKE SECTION OF
THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
601 Pavonia Avenue, Jersey City, NJ 07306
Paper presented at the NSRP 1988 Ship Production Symposium,
Edgewater Inn, Seattle, Washington, August 24-26, 1988

Wired for Disaster: Cableway Improvement Program

No. 9A

Verle Hendricks, Visitor, NAVSEADET (PERA CV), Bremerton, WA

Jim Pokrywka ViSitOr, and Cliff Creek, Visitor, American Systems Engineering Corp., Virginia Beach, VA

ABSTRACT

Throughout a Ship's lifecycle, as systems are installed, modified, or removed, breaches of the technical requirement for proper installation of electrical and electronic cables occur. The majority of these deviations are a result of insufficient attention to cable installation requirements during ship design or production caused by shortcuts to reduce costs or meet schedules, and overall poor workmanship.

In January 1984 on the USS TATTNALL (DDG-19) a fire originating in a locked compartment spread through electrical cableways. Before being contained, this fire caused loss of life, extensive damage to critical system and prevented the ship from completing her assigned mission. An investigation revealed that the fire started as a result Of cableway discrepancies. Further Surveys performed on various ships revealed findings which included:

The cableway discrepancies found on the USS TATTNALL (DDG-19) were not isolated, but common to the fleet in great numbers.
Fifteen to Twenty percent of all dead-ended cables were found to be still electrically energized.

TO develop a systematic and trackable method of removing cableway discrepancies and reduce the risk of fire, Commander Naval Air Force, Atlantic Fleet (COMNAVAIRLANT) tasked American systems Engineering Corporation (AmSEC) and Naval See Systems Command Detachment (NAVSEADET) (PERA CV) to develop a program to assist in correcting cableway discrepancies aboard aircraft carriers. The program since displayed great success evidenced by Navy wide attention and expansion of the program to include aircraft carriers under Commander Naval Air Force, Pacific Fleet (COMNAVAIRPAC).

INTRODUCTION

The objective of this paper is to introduce the cableway installation, repair, and removal program currently being implemented on U.S. Navy aircraft carriers. The program, entitled "Carrier Life Enhancing Repairs (CLER) Cableway Improvement Program (CIP)", is a four phased program and was developed considering the following objectives and goals:

Train and certify shipboard personnel to inspect, install, end repair cables and cableways.
Increase shipboard personnel awareness of cableway safety hazards.
. Remove excess weight, especially on main deck and above.
. Clear cableway congestion.
Correct cable and cableway hazards and discrepancies.
. Train shipboard personnel to perform quality assurance Of work accomplished by repair or modernization activities.
. Document work to be accomplished and completed work in order to effectively track progress of the program.

The four phases of the Program are as follows:

. Phase one - Ship's Force training and certification program
. Phase Two - Organizational Level (Ship's Force, correction Of cableway discrepancies
. Phase Three - Depot Level (Industrial Activity) Correction of cableway discrepancies
. Phase Four - Documentation and Tracking

The first phase trains and certifies selected shipboard personnel to properly and safely remove and install electrical cable and correct other associated electrical cableway adversities. It is conducted onboard each ship with each student

participating in both "hands-on" activities and formal classroom instruction. In the second phase, shipboard personnel utilize the skills learned in the training phase in the removal of unused cables and correction of associated cable and cableway hazards, prior to the scheduled overhauls or availabilities. The second phase work includes all cable runs up to the major cableways. The third phase accomplished by industrial activities during overhauls or availabilities. In this phase, the discrepancies in the major cableways are removed. The fourth and final phase is the documentation and tracking of completed or new work to be accomplished utilizing compartment-alization diagrams based on the ship's Booklet of General Plans.

A multitude of cableway problems have bee" detected and corrected as a result of the program. The most common types cableway discrepancies identified for repair include:

- Exposed or improperly end-sealed dead-ended Cables
- Improperly spliced cables
- Exposed conductors in junction boxes, Power panels, fuse panels, and equipment
- Violated firetight, smoketight and watertight boundaries
- Overcrowded cableways
- Overheated cables
- Missing o r improper cable banding
- Insufficient or improper cable hangers
- Chafed or cut cables
- Cables run outside of cableways

PHASE ONE - THE TRAINING AND CERTIFICATION PROGRAM

The first phase implemented in the cableway Improvement Program (CIP) is the training and certification Of shipboard personnel to identify and correct discrepancies associated with the ship's electrical and electronic equipment and cableways. The training is composed of a NAVSEA approved formal training course of instruction in modular form, developed from and adhering to the Electric Installation Standard Methods Manual (EPISM) S9300-AW-EDG-010.

Shipboard training involves 40 hours of formal classroom instruction utilizing selected Ship's Force personnel with electrical and electronic backgrounds. Class size is limited to a maximum of 20 students due to the extent of actual hands-on participation of each student in various phases of the instruction. The training program is conducted in 5 segments:

- Video tapes which introduce the lesson topics
- Lecturing by instructor with visual aids
- Practice exercises located in student guides
- Instructor demonstrations
- Student "hands-on"

classroom instruction consists of 16 modules as follows:

- Overview and introduction
- Special tools and equipment
- Stuffing tubes
- Penetration of equipment and connection boxes
- Multicable penetrators
- Hangers
- Banding
- Chafing rings
- Cable pulling techniques
- Dead-ending cables
- Cable splicing
- Repairing insulation damage
- Testing cables
- Inspection of cables and cableways
- Blueprint reading
- Cable Removal Plan of Action

Student participation during the training is enhanced by "se of a student guide which contains the 16 modular 1essons with additional practice exercise sections. Each module, where applicable, is supplemented by excerpts from the EPISM to heighten student understanding of the subject matter as well as to encourage practical use of the EPISM. In addition, where specific equipment, materials, or tools are addressed, supplements have been inserted giving current noun name, manufacturer, national stock number (NSN), cost, and quantity needed to perform. a given task. In the event that specific tools and materials are not available through the Navy stock system, manufacturer's data is provided with the information necessary to procure the required items.

To fully ensure success of the training in Phase One, tools and materials associated with specific modules are also included in the training package. These tools and materials allow instructor classroom demonstrations, and student hands-on practical application of the lessons taught. I" some applications, classroom mock-ups are the only means of student training due to inaccessibility of equipment and time constraints imposed by numbers of students and training requirements.

At the conclusion of the training phase, NAVSEA approved certification forms are issued for each student completing the entire course of

instruction. The certification forms are designed to allow partial certification for students not completing the entire 16 module training. The certification forms are in two parts, part one being the certification of having attended the classroom training, part two of the certification form is for successful completion of the "hands-on" practical application portion of the training. Certification forms once completed will be forwarded to NAVSEA Code 07Q with a copy retained onboard the ship to become a permanent entry individual student's service record. Certified shipboard personnel become part of a NAVSEA inspection team under NAVSEAINST 9304.1A "Shipboard Electrical Cable and Cableway Inspection and Reporting Procedures".

PHASE TWO - ORGANIZATION LEVEL (SHIP'S FORCE) CORRECTION OF CABLEWAY DISCREPANCIES

I" the second phase of the program, shipboard personnel take an active and independent role in the correction of cable and cableway deficiencies, and the removal of unused cables. These activities are undertaken in preparation of Phase III which occurs during an industrial ship availability e.g., Complex Overhaul , Selected Restricted Availability (SRA), or Service Extension Program (SLEP).

Ship's Force personnel, use a" Engineered Maintenance Plan (EMP) for systematic Cableway Improvement and correction of ship's cable and cableway discrepancies. The EMP for Cableway Improvement is a major element in a successful shipboard effort. provides all of the program and ship specific information required to successfully implement and track the progress of the program. Specifically, the EMP contains background information, a formal statement of work, technical guidance far execution of the work and charts/diagrams for effective monitoring of program progress.

A comprehensive statement of work defines the work to be accomplished by Ship's Force personnel as cable and cableway discrepancies are discovered. The general approach dictated by the Statement Of Work is as follows:

- Electrically test all unused cables for applied voltage observing standard electrical safety precautions as outlined in OPNAVINST 5100 series.
- Remove banding from alternate hangers to maintain cables in place but facilitate the removal Of unused cables.
- Open metal and nylon stuffing tubes
- Unpack chafing rings and multi-cable penetrations.
- Remove unused cable in 3 to 4 foot sections to prevent damage to other installed cables.
- Endseal all dead-ended cables not removed.
- Band all cables to installed hangers.
- Replace any missing or damaged cable hangers or cable hanger studs.
- Plug all open metal and nylon stuffing tubes, box connectors, multi-plugs, and multi-transits.
- Pack all firestop chafing rings with type HF sealant and firestop caulk.
- Repair all insulation damage.
- Splice cables if extensively damaged and continued use is required.

The formal statement of work is supplemented by specific technical guidance provided to assist shipboard personnel in a systematic method of discovery and correction of cableway related deficiencies. This technical guidance is first and foremost provided by the formal classroom training received by the shipboard certified inspection and repair team. guidance is provided by NAVSEA $9300 AW-EDG-010/EPISM; "Electric Plant Installation Standard Methods" and by NAVSEAINST 9304.1A; "Shipboard Electrical Cable and Cableway Inspection and Reporting Procedures". Strict compliance to procedure and documentation coupled with a quality assurance program provides long term improvement to the material condition of electrical cables and cableways.

To facilitate the task of implementing and tracking the program, each aircraft carrier is broken into well defined zones from the Booklet of General Plans. Cable and cableway work is usually concentrated on main deck and above due to the fact that most of the ship's electronic equipment is located in the upper decks. In addition, the most favorable effects on ship stability are generated by topside weight removal. A zone is determined by three means, with the first consideration being major or suitable frames for boundaries. An additional consideration is the actual "umber of compartments within the designated boundaries. The last consideration is that a zone should not contain more compartments/work/area than is reasonable for a three man team to complete the inspection and correction procedures within 30 days. It should be noted here that the inspection and correction team is only dealing with

discrepancies within compartments and areas peripheral to the ship's main cableways. Dead ended cables and related deficiencies which enter into main cableways are tagged and recorded for accomplishment during Phase III.

The inspection procedure utilized by the ship's team is aided by two tools, NAVSEAINST 9304.1A and a NAVSEA generated deficiency report. NAVSEAINST 9304.1A defines cable and cableway deficiencies into three distinct categories:

Immedlate Hazard Those items which are, or have the immediate potential to be, personnel *safety hazards,* electrical fire hazards, or which negate firebreak integrity.

Potential Hazard Those items which require corrective action to ensure continued reliable and safe performance or maintain watertight integrity but are not of immediate danger to personnel or equipment.

Nonhazardous - Those items which are not hazardous to personnel *and* equipment but are not in compliance with approved standard installation practices.

Fleet Commander funded NAVSEA certified inspection teams, using the criteria es outlined above, conduct initial surveys on selected aircraft carriers. The survey data is then compiled into a computer data base. Deficiencies found are sorted by level and compartment end linked to each respective zone. The correction of these identified deficiencies, es well as a thorough inspection procedure by Ship's Force, will restore the ship's electrical and electronic systems and cableways to a safe condition within the proper installation specifications. In addition, cableway space is made available for new shipboard installations.

A comprehensive tracking system and completion checklist to be utilized by Ship's Force to manage the cable and cableway repair effort is also included in the EMP. These tracking aids are used in conjunction with a detailed breakdown of the ship's zones. Each zone description contains information relating to location and a complete listing, by compartment number, of all compartments located within the zone. Lastly, the NAVSEA deficiency report for each zone is provided.

A removal schedule based primarily upon weight removal is also included for management planning. The actual prioritization of zone work completion is governed by criteria associated with ship alterations and modernization installations. These priorities are therefore established by either the ship's Maintenance Planner or the ship's Maintenance Manager and Electrical Officer.

PHASE THREE - DEPOT LEVEL (INDUSTRIAL ACTIVITY) CABLEWAY IMPROVEMENT

The third phase of the program is accomplished by industrial activities during a Complex Overhaul (COH) Selected Restricted Availability (SRA), or Service Life Extension Program (SLEP). After Ship's Force purges deficiencies from the peripheral compartments leading to the major cableways, the industrial activity will open the main cableways, remove the unused cable end correct miscellaneous discrepancies. This work is generally funded by NAVSEA (PMS 312) under "eight removal ship alterations (SHIPALTS AVT 0040, CV 3800K, or CVN 3801K) and is normally concurrent with other cableway work being accomplished by other SHIPALTS or modernization programs. The amount Of cable (tonnage) removed is then reported to the ship's planning yard to allow for weight and moment computation. The industrial activity accomplishing the work is then responsible for restoring the cableways in accordance with the guidelines set forth in the Electric Plant Installation Standard Methods Manual (EPISM).

During Phase Three, NAVSEA certified shipboard personnel and Supervisors of Shipbuilding (SUPSHIPS) personnel perform the quality assurance functions for this work. Shipboard personnel must inspect all opened cableways to be certain that all electrical cableway deficiencies are corrected prior to rebanding. In particular, attention is given to the following es quality checks:

- All dead-ended cables are removed or properly end sealed where they exit the established work zone.
- Unused stuffing tubes are properly blanked.
- Chafing rings are packed with high temperature sealant (Type HF).
- channel rubber is used around transmission, coaxial, or robber jacketed cables prior to bending.
- Cableways are arranged, "here possible, with the larger cables in the center.
- Open multicable transits are properly blanked.
- Newly installed chafing rings allow for an additional fifty percent growth for new cable installation.
- At least every fourth horizontal

hanger and every vertical hanger is banded.

. Any damaged cable is either replaced or properly spliced.

The supervisors of shipbuilding (SUPSHIPS) are also required to perform certain quality assurance functions es follows:

. Periodically audit contractor practices end conduct onboard inspections to ensure compliance with NAVSEAINST 9304.lA.
. Establish a formal quality assurance program to ensure that the work done by private sector facilities conforms to the EPISM, NAVSEA S9300-AW-EDG-010.
. Conduct a final cableway inspection in the areas affected by the work package prior to final ship acceptance and/or end of repair availability.

These two activities, Ship's Force and SUPSHIPS, working as separate and independent entities have assured a successful quality assurance inspection program for all aircraft carriers during a depot level availability.

PHASE FOUR - PROGRAM DOCUMENTATION AND TRACKING

Phase Four, the final phase of the program, entails the documentation and tracking of completed or new work. The tracking system consists of three distinct elements as follows:

. Color coded Booklet of General Plans.
. Tracking Matrix/Completion Check List
. Automated Work Requests (AWR's)/ Ship's Maintenance Action Forms (2-KILO)

Copies of the Booklet of General Plans are color coded to track work completed in each zone. They aid cableway inspection teams to quickly identify compartments and zones where outstanding work remains to be accomplished. The tracking matrix/ completion check list used to record work already accomplished, or work yet to be completed is included in the Engineered Maintenance Plan (EMP) and serves the following functions:

. Determines if the work was accomplished in accordance with the EMP
. Provides a means of documenting and updating of work accomplished on the plan
. Provides a means of feedback to monitor the effectiveness of the work prescribed in the EMP in order to make adjustments to the plan if required.

Upon completion of the removal/ repair work, the accomplishing activity Conducts a final inspection in the applicable zones. The inspection serves to document the completed removal/repair work and complete the Pre-prepared Ship's Maintenance Action Form or Automated Work Request (AWR), utilizing the ship's SNAP computer system, indicating the number of feet of cable removed from the applicable zone. The size or type of cable is not identified, es NAVSEA engineers have developed a formula for computing approximate weight removed. This formula is based on the average size cable know" to be installed in aircraft carriers in corresponding areas.

RESULTS

NAVSEADET (PERA CV), es Cableway Improvement Program manager for COMNAVAIRLANT, COMNAVAIRPAC, and NAVSEA (PMS 312) is successfully providing designated shipboard personnel the training, tools and materials required to implement NAVSEAINST 9304.1A "Shipboard Electrical Cable and Cableway Inspection and Reporting Procedures". Since ninety percent of a11 cableways on aircraft carriers contain unused cables, removal of these cables by Ship's Force make it more cost effective to install new cables without having to construct new cableways. Cable weight removal costs are approximately eight to ten thousand dollars per ton, or about half the normal fifteen to thirty thousand dollars per ton for other weight removal items. The Carrier Life Enhancing Repairs (CLER) Cableway Improvement Program has integrated Type 'Commander repairs and NAVSEA (PMS 312) "Weight and Moment Compensation' SHIPALTS to accomplish the removal of these cables.

To date, certification training has been completed on fifty percent of -the Navy's aircraft carriers and Cableway Engineered Maintenance Plans have been developed and implemented on ‘about twenty percent of the carriers. The remaining carriers are scheduled to commence the implementation of the program in the near future.

In addition, students who attended the cable and cableway training course of instruction have returned to their respective work centers with useful knowledge for future application. In passing the training received to their peers, a higher degree of professional-ism is realized by the ship and the Navy. Work center supervisors, division officers, and other ship's officers attest to the quality of workmanship generated by Ship's Force personnel having participated in the Cableway Improvement Program.